THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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THE CAPE CABLE.

IT has been a satisfaction to the general public, as well as to electricians, to learn that the Government have resolved to lose no time in connecting the South African Colonies by cable to the mother country. On February 21 an influential deputation, including Col. Mure, Sir J. Hay, M.P., Mr. Donald Currie, and a number of influential members of Parliament, waited upon Sir Michael Hicks-Beach, who stated that several definite proposals for a cable were now under consideration of the Treasury and Post Office authorities. The recent disaster in Zululand has rendered it incumbent on the Government to possess cable communication with Natal as soon as possible, and forced on the long-deferred realisation of a cable to the Cape. The route chosen will almost certainly be the east coast route, from Aden to Natal. The reasons in favour of this route at such a time are obvious. It is shorter and better known than the west coast route, and the duplicate Mediterranean and Red Sea cables of the Eastern Telegraph Company connect it more securely to England than could the Brazilian Submarine Company's line from St. Vincent to Lisbon. Sir James Anderson has somewhere stated that this cable might be made and laid by next October; but, as was pointed out by Col. Mure to Sir Michael Hicks-Beach, there were 1400 miles of the Australian duplicate cable already made which could be purchased, so that the time of completion of the line might be shortened.

It must not be forgotten, however, that although the east coast route is undoubtedly the safest and best in an emergency like the present, it cannot be considered an "alternative route," for to lay intercolonial lines of communication in the Mediterranean is trusting all the eggs to one basket. When the advantages of the new cable have been felt, however, we may expect that a west coast cable will soon be achieved, not only as an alternative line but in order to link our west coast possessions with England.

ON ELECTRICAL INSULATION IN HIGH VACUA.

By WILLIAM CROOKES, F.R.S.

THE experiments here described were tried nearly two years ago. They were suggested by some observations I was then making on the passage of an induction current through highly exhausted tubes. The main branch of the research being likely to occupy my attention for some time, I may be unable to return to these less important offshoots. I have ventured, therefore, to embody them in a short note for the "Proceedings of the Royal Society."

A pair of gold leaves were mounted, as for an electroscope, in a bulb blown from English lead glass

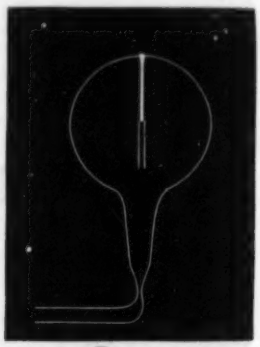


FIG. 1.

tubing. The leaves were attached to a glass stem, and the lower part of the bulb was drawn out for sealing to a Sprengel pump, as shown at fig. 1. A stick of ebonite, excited by friction, was generally used as the source of electricity, but any other source will do as well, if not too powerful.

No special attention was paid to the action of electricity on the leaves in air or in moderate vacua, as it agreed with what is well known. The exhaustion was pushed to a very high degree (about the millionth of an atmosphere); it was now found that the excited ebonite had a much greater effect on the gold leaves than it had at a lower exhaustion; but for a long time I was not able to charge the leaves permanently, as they fell together as soon as the source of electricity was removed.

When a hot substance was brought near the bulb facing a gold leaf, so as to warm the glass, molecular repulsion took place, and the leaves retreated from the warm spot, standing out at an angle of about 45°. As the glass cooled, the leaves resumed their former vertical position.

While the leaves were repelled from the hot glass, it was found that the excited ebonite had a very powerful action on them, and if it were brought near hastily, the leaves flew off to the side of the glass, destroying the apparatus. By careful management, however, the source of electricity could be brought near the warm spot of glass, when, after one or two trials, the leaves suddenly extended at an angle to each other. The appearance was as if a spark had been able to pass across the bridge formed by the line of advancing and retreating molecules connecting the hot glass with the gold leaves. The ebonite was now removed and the glass allowed to cool, when it was found that the repulsion of the leaves was permanent. The rubbed ebonite would attract and repel them as it was moved to and fro, but the angle, formed by the leaves with one another, remained unchanged. A warm body brought near the glass opposite one leaf would repel the pair as a whole; on then warming the opposite side of the glass, repulsion on that side took place, the angle of the leaves being somewhat diminished, but, on cooling, the leaves opened again to their former extent.

When the glass bulb was strongly heated by a spirit flame the leaves suddenly discharged and fell together.

Another bulb (fig. 2) was prepared, containing a plate of mica *a*, which could be suddenly placed between the gold leaves *b b*. The plate of mica was longer and wider than the gold leaves, and was connected with a small piece of iron wire, capable of moving up and

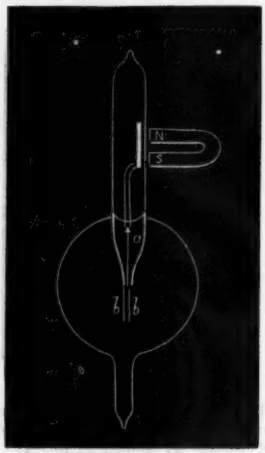


FIG. 2.

down a tube sealed into the top of the bulb. By means of an outside magnet the mica plate could thus be lowered between the gold leaves or raised out of their way, as desired. The tube was exhausted in about the millionth of an atmosphere, the mica plate being held quite above the leaves. One side of the bulb was then heated, and the leaves permanently charged by means

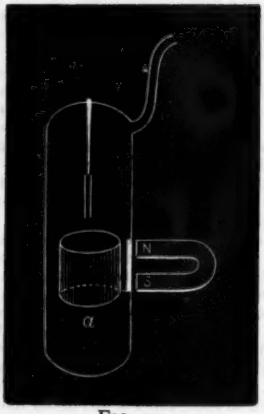


FIG. 3.

of the excited ebonite. The mica plate was now carefully lowered. As it came between the gold leaves they diverged further apart, and kept so as long as the mica plate was between them. On removing the plate the leaves reassumed their former divergence. This could be repeated any number of times.

A similar piece of apparatus (fig. 3) was made, only instead of a mica plate coming between the leaves, a mica cylinder *a*, was made capable of being raised and lowered outside the divergent leaves. I was not able to get entirely concordant results with this, owing to the friction of the mica developing electricity on the inner surface of the glass tube; but in all cases, when the cylinder was raised until it covered the electrified

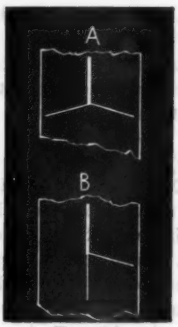


FIG. 4A.

leaves, it had the effect of diminishing the angle which they formed with each other.

The following experiments were also tried. The leaves being separated about 160°, as at fig. 4A, one side of the tube was slightly heated by a spirit flame. The leaf on that side fell to a vertical position, and remained so when all was cold, the other leaf sticking out as before, as at B. This seems to show that the divergence of the leaves in this case was not so much

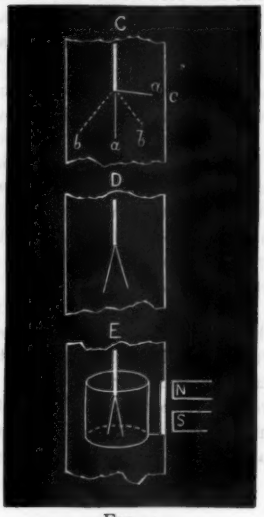


FIG. 4.

due to their mutual repulsion, as to an attraction exerted on each of them by the inner surface of the glass tube. The remaining divergent leaf could be slightly lowered when the glass tube above it was warmed with a bunch of cotton wool dipped in hot water. On cooling, the leaf rose again to its original position. When this side of the tube was also heated

with a lamp, the leaf was repelled down, but not so readily as the other had been, and when the tube got cold, it rose to nearly its former position. This was repeated several times with uniform results. When the leaf was repelled down, the vertical leaf also moved away, so as to keep the same angle between them. This shows that the leaves themselves were also charged.

Fig. 4, C. shows the two positions of the leaves, *a a* before applying heat to the side *c* of the tube, and *b b* after heating the glass at *c*.

The tube was now heated on both sides, causing the leaves to come nearer together, as shown at fig. 4, D. While the glass was warm the cylinder was raised so that it surrounded the leaves; this caused them to get a little closer together, and they kept in this position, shown at E, till the whole apparatus was quite cold.

After remaining thus for some time, the cylinder was lowered, when the leaves widened out and took up the position shown at *b b*, fig. 4, C. The leaves did not return to the position *a a*, showing that now their divergence was owing to their own mutual repulsion, and not to an attraction of one or other to the electrified glass.

In December, 1877, I totally immersed one of these exhausted glass bulbs in a vessel of water; the gold leaves having previously been charged, and standing at an angle of 112° from one another, as at fig. 5. The

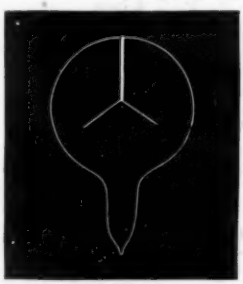


FIG. 5.

water was connected electrically with "earth," and the whole was set aside in a cabinet on the 1st of January, 1878.

At the present time, after having remained in this condition for thirteen months, the leaves form exactly the same angle with one another which they did when they were first put in the cabinet.

After this experience I think we may consider that at an exhaustion of a millionth of an atmosphere, air is an absolute non-conductor of statical electricity. It is, therefore, legitimate to conclude that the vacuum of interstellar space offers equal obstruction to the discharge of electrified bodies, without necessarily interfering with their mutual repulsion if similarly electrified. It is possible that in these facts an explanation may be found of some obscure celestial phenomena.

GOWER'S TELEPHONE.

THE chief and generally acknowledged defect from which the telephone suffers is the still small voice in which it delivers its utterances, the listener being obliged to place the telephone close against his ear, bawl the speaker never so loudly. What we want is a telephone capable of so modulating its voice as to be able, when desired, of giving out the messages entrusted to it either *sotto voice* or in a tone audible to a number of persons at once, a result which, gushing journalism notwithstanding, has not yet been achieved.

It is therefore with considerable satisfaction that we hail the improvements effected by Mr. Gower, of Paris, as a step in the right direction; for although the telephone he has produced does not quite come up to the above-mentioned standard, it is nevertheless the best telephone we have yet heard.

Associated with Professor Bell in the birth of the telephone in America, Mr. Gower has followed it up through the various stages of its evolution, the instrument here described being the result of long and careful experiment.

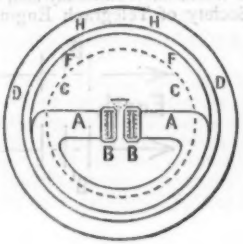


FIG. 1.

Fig. 1 shows the internal arrangement, in which A A is the magnet, B B the coils, D D the box, F F interior circumference of box, H H exterior circumference. This box is sometimes of wood, sometimes of copper; in the latter case the thickness is less than that shown. The dotted circle C C shows the position of the

FIG. 2.

diaphragm, removed to show the magnet. The dotted line E shows the position of the whistle described below.

It will be seen that although the magnet occupies but a small space, its disposition produces a very powerful magnetic field (after an idea borrowed from Faraday). The diaphragm employed is much

thicker than that of the ordinary telephones, and is of course much larger. A flexible speaking-tube (fig. 2) attached to the case of the instrument allows the speaker to have the telephone fixed in any convenient position on a table or against a wall, and to talk to it without leaving his seat.

One notable feature in the new telephone is the call arrangement. This consists simply of a reed (harmonium or concertina form), beds and batteries being dispensed with. An oblong aperture cut in the diaphragm, while in no way affecting the talking power of the instrument, allows a sharp puff of air sent into the tube to pass through and agitate the reed-tongue; a sound resembling that from a toy-trumpet being produced at the receiving end loud enough to call attention in any part of the room in which the instrument is situate.

In the exhibition of Mr. Gower's telephone recently made by M. du Moncel, at the Académie des Sciences and the French Physical Society, the instrument was so delicately adjusted that it was possible, by the application of large funnels in place of the ordinary mouthpiece, to cause words imparted at the sending end to be audible several yards from the receiving telephone.

We expect to hear more of this instrument yet.

COWPER'S TELEGRAPHIC PEN.

ANOTHER telegraphic marvel was brought to the notice of the world on Wednesday last, at the meeting of the Society of Telegraph Engineers, by its inventor Mr. E. A. Cowper, the well-known engineer. Cowper's Telegraphic Pen is the first literal telegraph, and as the telephone permits any person to converse by wire, so this supplementary invention enables any one to write by wire. We recently gave an account of D'Arlincourt's autographic apparatus (see TELEGRAPHIC JOURNAL, January 15th) by which a similar purpose is effected in a roundabout fashion, little thinking then that that beautiful but complex instrument was destined to be eclipsed by the simple and versatile telegraphic pen of Mr. Cowper.

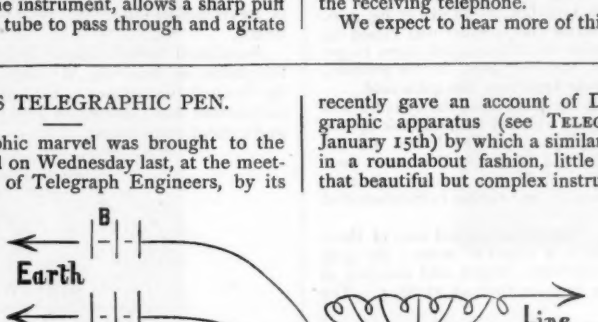


FIG. 1.

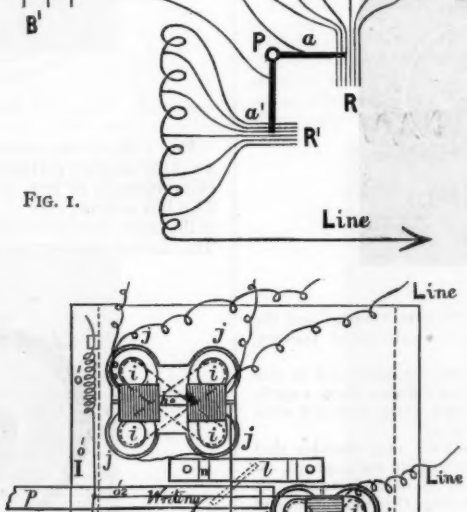


FIG. 2.

In designing his pen Mr. Cowper was guided by the principle that all points in a curve can be determined by the perpendicular length of two lines

drawn from fixed co-ordinates at right angles to each other, just as the track of a ship is laid down on a chart by its latitudes and longitudes. Every point in a line of writing therefore can be determined by its distance from such fixed lines, every stroke of the writing pencil or pen can be resolved into horizontal and vertical components. It follows that if these components could be transmitted by wire continuously as the writing is being done, and recombined at the receiving end on a pen or pencil there, the latter would reproduce the original writing. It is this feat which Mr. Cowper has accomplished.

He employs for the purpose two separate circuits, one to transmit the up and down range of the pen, and the other the sidelong range. Each circuit consists of a battery, a set of variable resistances and the line, and for the sake of explanation it will be sufficient to consider any one of these, say that which transmits the up and down range of the sending style. Fig 1 represents in theory the connections for sending a written message, P is the pencil which the writer takes in his hand and writes with in the ordinary manner; the paper being pulled by clockwork slowly under the point. A metal arm *a*, fitted at its point with a contact piece, is attached to P, and the working pole of the battery is connected to *a*. Between the arm *a* and the line, there is inserted a series of resistance coils R, whose contacts or poles are thin metal plates, placed edgewise, and insulated from each other by sheets of paraffined paper. There are thirty-two of these coils and plates. Now the arm *a* is so connected to the pencil P that as the latter writes the arm moves lengthwise, that is in the direction of its axis, across the edges of the resistances R to an extent equal (or it may be proportional) to the vertical range of the pencil. By pushing across these resistances in this manner it puts in or takes out of circuit a number of the resistances proportional to the extent of its movement. Hence the strength of the current in circuit is varied according to the vertical range of the pen. Similarly in the other circuit provided for the transmission of the side-long motion, the arm a^1 slides over the resistances R^1 and puts in or takes out resistances which vary the strength of the current according to the direct sidelong motion of the pencil. It will be understood that the actual movement of the pen is very slight, being comprised within the dimensions of any single letter formed, for the movement of the paper itself obviates the necessity of the pen shifting from letter to letter.

The receiving apparatus is sketched in fig. 2. It consists for each line of two hollow galvanometer coils *i i*, with a needle *k*, pivoted so as to present its poles within their interiors. Four electro-magnets *j j j j*, which, however, might be permanent magnets, are placed underneath to control the zero of the needle. From one end of this needle a fibre leads to the writing pen, which is a fine glass siphon *k*, drawing off aniline ink from a small well. This fibre o_2, is kept taut by being tied to the cross fibre o_1, which is stretched by the spring *o*. For the other circuit there is a similar galvanometer arrangement with a thread o_2^1, kept taut by the thread o_1^1 and the spring o^1. Now when the current from each line passes through its proper galvanometer, by the wires shown, the needles move to degrees corresponding to the strength of the currents flowing, and, therefore, approximately to the ranges of the writing pencil at the sending station. By the cross fibres these two motions are combined on the siphon, and the latter inscribes the letters of the message on a moving slip of paper *p*. This copy may be either larger, smaller, or of the same size as the original writing. The advantages of Cowper's Writing Telegraph are obvious on a little reflection. It will supplement the telephone in business by giving *written* orders; or it will be useful in the field as a copying telegraph, while for private and confidential purposes, it will be valuable, since any unskilled person may use it, and secret marks may readily be sent.

MEASURING AND REGULATING ELECTRIC CURRENTS.

By C. WILLIAM SIEMENS, D.C.L., F.R.S.

THE dynamo-electric machine furnishes us with a means of producing electric currents of great magnitude, and it has become a matter of importance to measure and regulate the proportionate amount of current that shall be permitted to flow through any branch circuit, especially in such applications as the distribution of light and mechanical force.

On the 19th June last, upon the occasion of the Soirée of the President of the Royal Society, I exhibited a first conception of an arrangement for regulating such currents, which I have since worked out into a practical form. At the same time, I have been able to realise a method by which currents passing through a circuit, or branch circuit, are measured, and graphically recorded.

It is well known that when an electric current passes through a conductor, heat is generated, which, according to Joule, is proportionate in amount to the resistance of the conductor, and to the square of the current which passes through it in a unit of time, or

$$H = C^2R.$$

I propose to take advantage of this well-established law of electro-dynamics, in order to limit and determine the amount of current passing through a circuit, and the apparatus I employ for this purpose is represented in figs. 1 to 3 of the accompanying drawings. Letters of reference to the principal parts of the instrument are given in fig. 1.

The most essential part of the instrument is a strip (A) of copper, iron, or other metal, rolled extremely thin, through which the current to be regulated has to pass. One end of this thin strip of metal is attached to a screw (B), by which its tension can be regulated; it then passes upwards over an elevated insulated pulley (I), and down again to the end of a short lever, working on an axis, armed with a counter-weight and with a lever (L), whose angular position will be materially affected by any small elongation of the strip that may take place from any cause. The apparatus further consists of a number of prisms of metal (P), supported by means of metallic springs (M), so regulated by moveable weights (W) as to insure the equidistant position of each prism from its

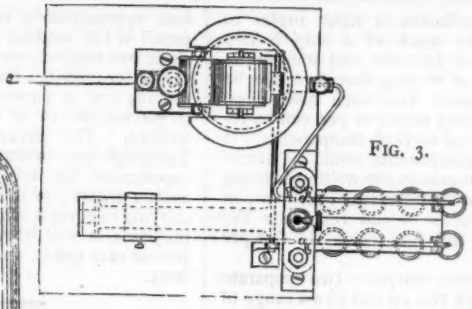


FIG. 3.

A.—*Sensitive strip.*
B.—*Tension screw.*
L.—*Lever.*
M.—*Metal springs.*
I.—*Insulated pulley.*
W.—*Adjusting weights.*
P.—*Contact prisms.*
S.—*Contact spring.*
T.—*Terminal.*
R.—*Resistance coils.*

FIG. 1.

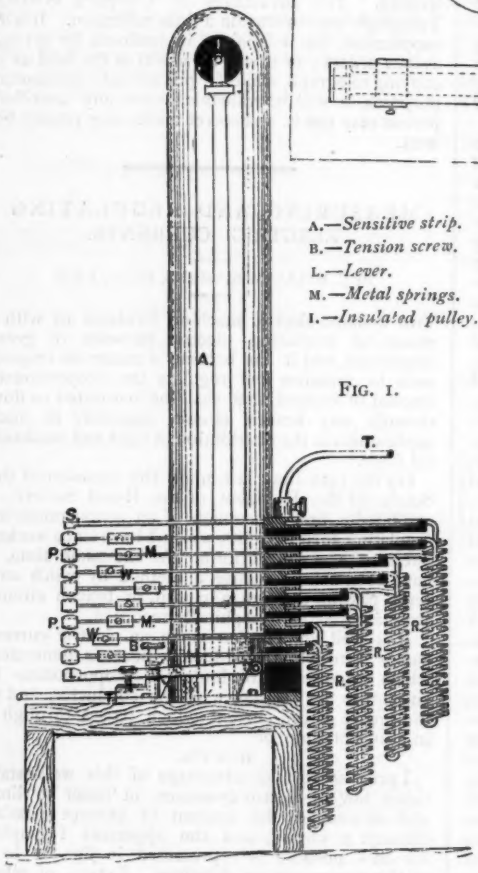
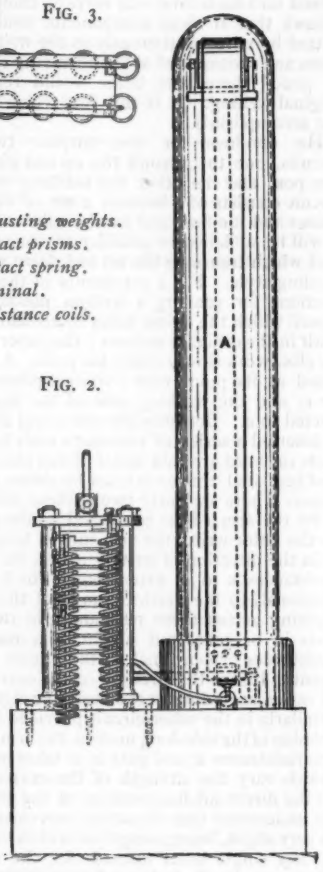


FIG. 2.



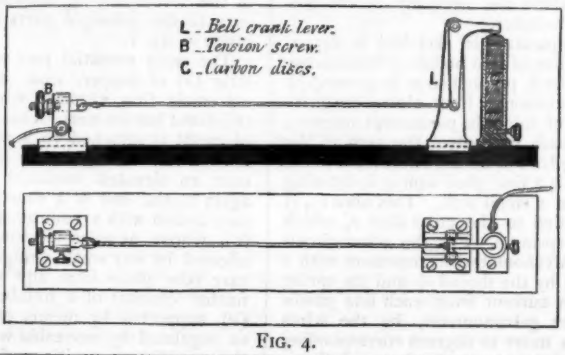


FIG. 4.

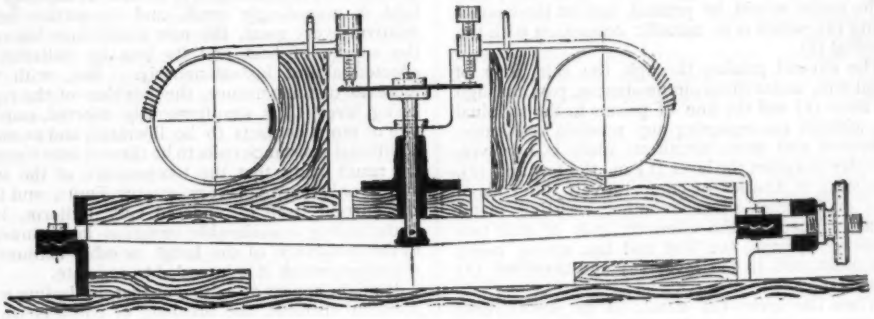


Fig. 5.

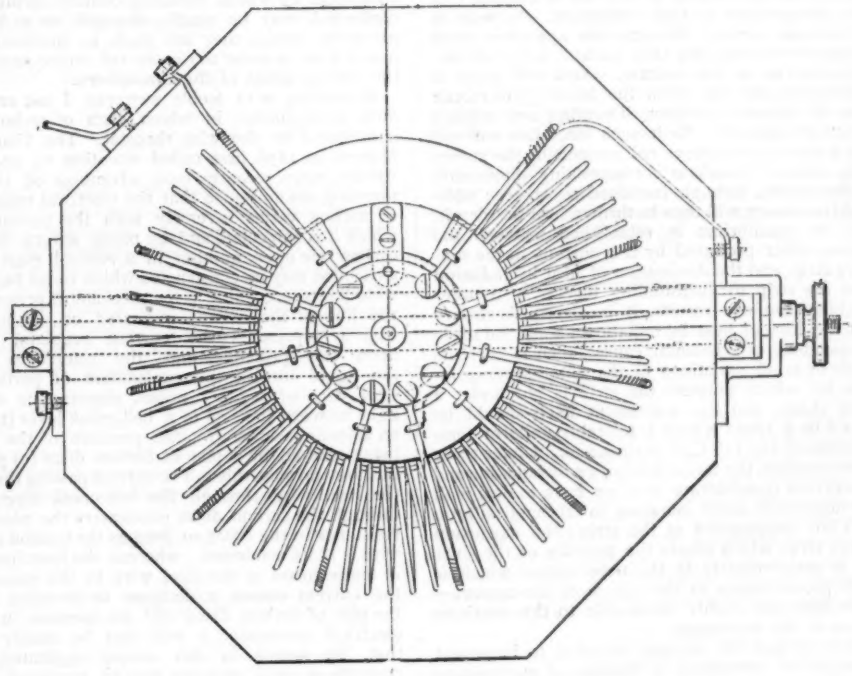


Fig. 6.

neighbour, unless pressed against the neighbouring piece by the action of the lever (L), in consequence of a shortening of the metallic strip. By this action, one prism after another would be brought into contact with its neighbour, until the last prism in the series would be pressed against the contact spring (S), which is in metallic connexion with the terminal (T).

The current passing through the thin strip of metal will, under these circumstances, pass through the lever (L) and the line of prisms to the terminal (T), without encountering any sensible resistance. A second and more circuitous route is, however, provided between the lever (L) and the terminal (T), consisting of a series of comparatively thin coils of wire of German silver or other resisting metal (R, R), connecting the alternate ends of each two adjoining springs, the first and last spring being also connected to the lever (L) and terminal (T) respectively.

When the lever (L) stands in its one extreme position, as shown in the drawing, the contact pieces are all separate, and the current has to pass through the entire series of coils, which present sufficient aggregate resistance to prevent the current from exceeding the desired limit.

When the minimum current is passing, the thin metallic strip is at its minimum working temperature, and all the metallic prisms are in contact, this being the position of least resistance. As soon as the current passing through the apparatus shall increase in amount, the thin metallic strip will immediately rise in temperature, which will cause it to elongate, and will allow the lever (L) to recede from its extreme position, liberating one contact piece after another. Each such liberation will call into action the resistance coil connecting the spring ends, and an immediate corresponding diminution of the current through increased resistance; additional resistance will thus be thrown into the circuit, until an equilibrium is established between the heating effect produced by the current in the sensitive strip, and the diminution of heat by radiation from the strip to surrounding objects. In order to obtain uniform results, it is clearly necessary that the loss of heat by radiation should be made independent of accidental causes, such as currents of air or rapid variations of the external temperature, for which purpose the strip is put under a glass shade, and the instrument itself should be placed in a room where a tolerably uniform temperature of say 15° C. is maintained. Under these circumstances, the rate of dissipation by radiation and conduction (considering that we have to deal with low degrees of heat) increases in arithmetical ratio with the temperature of the strip; the expansion of the strip, which effects the position of the lever (L), is proportionate to the temperature which is itself proportionate to the square of the current—a circumstance highly favourable to the sensitive action of the instrument.

Suppose that the current intended to be passed through the instrument is capable of maintaining the sensitive strip at a temperature of say 60° C., and that a sudden increase of current takes place in consequence either of an augmentation of the supply of electricity or of a change in the extraneous resistance to be overcome, the result will be an augmentation of temperature, which will continue until a new equilibrium between the heat supplied and that lost by radiation is effected. If the strip is made of metal of high conductivity, such as copper or silver, and is rolled down to a thickness not exceeding 0·05 milim., its capacity for heat is exceedingly small, and its surface being relatively very great, the new equilibrium between the supply of heat and its loss by radiation is effected almost instantaneously. But, with the increase of temperature, the position of the regulating lever (L) is simultaneously affected, causing one or more contacts to be liberated, and as many additional resistance coils to be thrown into circuit: the result being that the temperature of the strip varies only between very narrow limits, and that the current itself is rendered very uniform, notwithstanding considerable variation in its force, or in the resistance of the lamp, or other extraneous resistance which it is intended to regulate.

It might appear at first sight that, in dealing with powerful currents, the breaking of contacts would cause serious inconvenience in consequence of the discharge of extra current between the points of contact. But no such discharges of any importance actually take place, because the metallic continuity of the circuit is never broken, and each contact serves only to diminish to some extent the resistance of the regulating rheostat. The resistance coils, by which adjoining contact springs are connected, may be readily changed, so as to suit particular cases; they are made by preference of naked wire, in order to expose the entire surface to the cooling action of the atmosphere.

In dealing with feeble currents, I use another form of regulator, in which discs of carbon are substituted for the wire rheostat. The Count du Moncel, in 1856, first called attention to, and Mr. Edison more recently took advantage of, the interesting circumstance that the electrical resistance of carbon varies inversely with the pressure to which it is subjected, and by piling several discs of carbon one upon another in a vertical glass tube, a rheostat may be constructed which varies between wide limits, according as the mechanical pressure in the line of the axis is increased or diminished. Fig. 4 represents the current regulator based upon this principle, and the references upon the figure furnish the explanation of parts. A steel wire of say 0·3 milim. diameter is drawn tight between the end of a bell-crank lever (L) and an adjusting screw (B), the pressure of the lever being resisted by a pile of carbon discs (C) placed in a vertical glass tube. The current passing through the steel wire, through the bell-crank lever, and through the carbon discs, encounters the minimum resistance in the latter so long as the tension of the wire is at its maximum; whereas the least increase in temperature of the steel wire by the passage of the current causes a decrease of pressure upon the pile of carbon discs, and an increase in their electrical resistance; it will thus be readily seen that, by means of this simple apparatus, the strength of small currents may be regulated so as to vary only within certain narrow limits.

The apparatus described in figs. 1 to 3 may be adapted also for *measurement* of powerful electric currents. The variable rheostat is in this case dispensed with, and the lever (L) carries at its end a pencil, pressing with its point upon

a strip of paper drawn under it in a parallel direction with the lever by means of clockwork. A second fixed pencil draws a second or datum line upon the strip, so adjusted that the lines drawn by the two pencils coincide when no current is passing through the sensitive strip. The passage of a current through the strip immediately causes the pencil attached to the lever to move away from the datum line, and the distance between the two lines represents the temperature of the strip. This temperature depends, in the first place, upon the amount of current passing through the strip, and, in the second place, upon the loss of heat by radiation from the strip; which two quantities balance one another during any interval that the current remains constant.

If C is the current before increase of temperature has taken place; R the resistance of the conductor at the external temperature (T); H the heat generated per unit of time at the commencement of the flow;

R′ the resistance, and H′ the heat, when the temperature T′ and the current C′ have been attained.

Then, by the law of Joule,

$$H' = R' C'^2.$$

But inasmuch as the radiation during the interval of constant current and temperature is equal to the supply of heat during the same interval, we have, by the law of Dulong and Petit,

$$H' = (T' - T)\, S,$$

in which S is the radiating surface. Then

$$R' C'^2 = (T' - T)\, S$$

$$C'^2 = (T' - T)\, \frac{S}{R'}.$$

But T′ — T represents the expansion of the strip, or movement of the pencil *m*, and considering that the electrical resistance of the conductor varies as its absolute temperature (which upon the Centigrade scale is 274° below the zero Centigrade) according to a law first expressed by Helmholtz, and that we are only here dealing with a few degrees difference of temperature, no sensible error will be committed in putting the value of R for R′, and we have the condition of equilibrium

$$C'^2 = m \frac{S}{R} \quad \therefore C' = \sqrt{m \frac{S}{R}}, \quad (1)$$

or, in words, the current varies as the square root of the difference of temperature or ordinates.

For any other condition of temperature T″ we have

$$C''^2 = \frac{S}{R} (T'' - T)$$

$$\therefore C'' = \sqrt{\frac{S}{R} (T'' - T)};$$

and

$$(C''^2 - C'^2) = (T'' - T - T' + T) \frac{S}{R} = (T'' - T') \frac{S}{R},$$

but for small differences of C″ and C′ we may put

$$(C''^2 - C'^2) = 2\, C'' (C'' - C'),$$

that is to say, small variations of current will be proportional to the variation in the temperature of the strip.

In order to facilitate the process of determining the value of a diagram in Webers or other units of current, it is only necessary, if the variations are not excessive, to average the ordinates, and to determine their value by equation (1), or from a table prepared for that purpose. The error committed in taking the average ordinate instead of the absolute ordinates, when the current varies between small limits, is evidently small, the variation of the ordinates above their mean value averaging the variations below the same.

The thin sensitive conductor may thus be utilised either to restrict the amount of electricity flowing through a branch circuit, within certain narrow limits, or to produce a record of the amount of current passed through a circuit in any given time.

[A newer form of Regulator than that illustrated above was shown by Dr. Siemens at the meeting of the Physical Society on February 22nd. In this form, which is shewn in plan and section in figs. 5 and 6, the fine steel strip $\frac{1}{30}$th millimetre in diameter, into which the current passes, is horizontal. A short spindle rests upon the middle of the strip by means of an insulating foot, and carries at its top a crown of radial springs, or it may be a circular plate. This spindle, with its crown of springs, is encircled by a helix of German-silver wire in the form of a ring. From certain fixed points in this helix, springs project, and these points are so depressed that, as the spindle rises to less or greater heights, one or more of the coils of the helix are thrown out of the circuit of the current by the spindle springs making contact with the coil springs. On the other hand, when the spindle sinks by the expansion of the strip, due to an increase of current, one or more coils of the helix are thrown into circuit. This new Regulator is an improvement on the older form, the pendulous contacts of which were apt to get dirty and interfere with its working.—ED. T. J.]

A NEW DUPLEX SYSTEM.

By S. M. BANKER.

As the method by which our duplex circuits are to be worked with as much ease and as little trouble to the telegraphist as an ordinary simplex Morse, notwithstanding the variations of our lines due to the climate, has not yet been invented, or if invented the fortunate inventor has not made it known, I have no doubt that the following method of working a duplex circuit may be interesting to many, as another solution of the problem without putting forward the least claim to any superiority over the differential system.

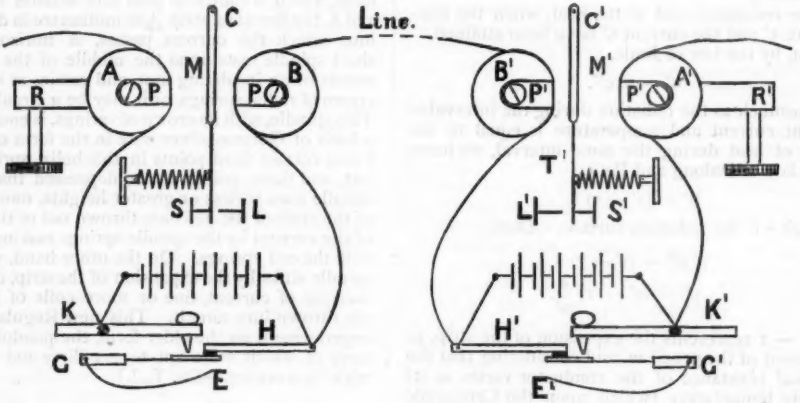
It consists of a specially constructed relay and a continuity preserving key besides the battery and Morse or Sounder.

On glancing at the accompanying fig. it will be seen that the relay is constructed of two coils A B, distinct and separate from each other. One, B, is fixed to the base of relay, whilst the other, A, is moveable by means of a rack and pinion R at right angles to the tongue of relay T. Each core of the

coils is prolonged top and bottom by pole pieces P turned towards each other, between which the permanent magnet M moves. This magnet is of horseshoe form, pivoted top and bottom at C with the legs between the coils, the upper leg of the magnet being lengthened, forming the tongue T for completing the local recording circuit at L and also giving a convenient point for attaching a spiral spring at S.

The key is a modification of the one originally invented by Nystrom, in which the lever K being pressed down moves the spring G off the contact H, so that the contact between G and K is made before the contact between G and H has been broken, thereby preventing any disconnection in the circuit.

This duplex is worked by the system of the current only going through one coil of the relay at a time from the sending station, and is accomplished by joining a pole of the battery, say copper, to the contact H of key and thence to line through the coil



B in such a direction that the magnet M is attracted when the spiral spring S is loose; then the other pole, zinc, is attached to lever of key K, and so to earth through the coil A, passing round the core in the same direction as in B, producing in the electromagnets opposite polarity and causing a pull on the magnet M always in the same direction. The spring G is joined to earth.

The stations adjust their own apparatus independently of each other, commencing by putting a piece of paper between contact H and G of key, pressing down lever K, putting current on line through B at same time increasing the tension of spring S until it just pulls the tongue of relay of local contact L, then prove the balance by sending dots rapidly. Now remove the piece of paper from between contacts H and G, allowing the current to pass through coil A to earth, and move the coil A by means of the rack and pinion until it just moves the tongue of relay T off the local circuit contact L. If these two operations have been performed correctly the working of the key does not affect the relay, and the relay is now in such a position that a very slight current coming from the line and traversing the coil so as to increase the magnetic effect of that coil will throw the tongue of relay over to the local contact L.

As this system compels the stations to work with assisting currents, it will be readily seen that the relay of one station responds to the movements of the key of the other station, whether the first station is sending or not. Further, the point of changing the battery from one coil to the other is so short by the arrangement of the key that it does not affect the signals.

REPORT ON ELECTRIC LIGHT EXPERIMENTS.

By LOUIS SCHWENDLER.

(*Continued from page* 48.)

ON SOME OF THE SCIENTIFIC RESULTS OBTAINED BY EXPERIMENT.

AT the commencement of this part of his report, Mr. Schwendler states that the units adopted have been those founded on the *Centimetre-Gramme-Second* system; Mr. Schwendler, however, employs the Siemens' unit of resistance throughout his report, although this unit is not based on the system referred to. The currents were measured by means of a tangent galvanometer, constructed in a special manner to suit the particular purpose; by its means all the currents between 1·6 to 38 Webers could be measured to an accuracy of 3 per cent. *at least.*

The Photometer for measuring the intensity of the light was constructed on the following principle:—

Two surfaces, equal in size and nature, were placed side by side, quite close together, and in the same plane.

One surface was illuminated by one light, the other surface by the other light, two equal flint-glass prisms being employed for the purpose.

The surfaces towards the eye were covered with

tracing paper, the top half of each paper being divided by fine pencil lines into small squares.

The equalisation of the intensities of the two lights under comparison was done by keeping the distance between the two lights *constant*, and moving the two illuminated surfaces *within* the constant distance.

This photometer is particularly well adapted for comparing the intensities of two differently coloured lights, as an experienced eye can easily distinguish the relative distinction between the pencil lines and the back ground of each surface, and if this relative distinction is the same in both surfaces, the two surfaces have equal intensity, no matter what the colour of each light may be. However, as a rule, the comparison of any two lights, was made by observing the two surfaces through a *red glass*. This glass, after trying a great variety of glasses, was found to have the convenient quality of making the colours of the electric light and of the standard light equal.

It was ascertained that this red glass absorbed all the violet, blue, and green rays, letting through only some yellow, more orange, and all the red; hence, if two lights under comparison contain the different coloured rays in different proportions, it may be said that by adjusting balance by means of the red glass, the ratio must become erroneous; however, actual experiments proved that this was practically not the case. If there was a difference it was quite within the limits of errors caused by the considerable variation in the intensity of electric lights.

Two electric lights compared with each other by means of the red glass and without it, gave practically the same ratio, and, further, the same electric lights compared each with a standard light gave a ratio sufficiently close to the one found by direct comparison of the two electric lights.

The Dynamometer employed to measure the transmitting force was that invented by Mr. Hefner von Alteneck, of Berlin, and is based on the principle, that the strains on either side of a driving strap are unequal, and are proportional to the force transmitted, a well-known and long recognised fact.

The Measurement of the Speed of the machines was made by means of a *Pocket-Counter*, a *Mercury Speed Indicator* by J. M. Napier, and a *Cycloscope*, an invention of Lieut. G. S. Clarke, R.E., and Professor McLeod. The principle of the cycloscope consists in employing a tuning fork or reed as the standard by which to measure velocities of rotation.

The *resistance measurements* were made by means of an ordinary Wheatstone bridge with Siemens' units.

The *Standards of Light* employed were:—the *Standard Candle* and the *Platinum Light Standard*; this latter standard being the light emitted from a piece of pure platinum weighing *(x)* Gm, and having the most convenient shape and size, when a constant current of *(y)* Webers passes through it. This standard produces a light of perfect constancy, so long as the current is kept constant, and further allows a correction to be made if the variation of the current is known.

RESULTS.

It was found that the standard candle, in order to produce the unit of light, does work at the rate of 610 meg-ergs per second, *at the least*. Further, by direct experiment, it was ascertained that the unit of light, as produced in an electric arc, by any one of the dynamo-electric machines under trial, and through a leading wire offering not more than 0·1 S.U. resistance, is produced at the rate of not more than 20 meg-ergs per second, including *all the work transmitted*, and the light measured in a line which passes through the centre of the arc, and stands normal to its axis. Hence the probable engineering margin in favour of the electric light is between 30 to 70, or equal to a mean of 50.

Dynamo-electric machine A produced the unit of light at a rate of not more than 10 meg-ergs per second.

Hence it may be safely asserted that the electric light produced by dynamo-electric machines is on an average 50 times cheaper than light by combustion. This is, however, true only as long as the light is produced in *one* arc.

The dynamo-electric machine with the greatest number of sections in the induction cylinder gives the steadiest current. Twelve sections were found *necessary* and *sufficient*.

The current produced by any dynamo-electric machine through a given constant total resistance in circuit, increases permanently with the speed of the induction cylinder. This increase of current for low speeds is more than proportional to the speed; afterwards it becomes proportional; and for high speeds the increase of current is less than proportional to the speed. The current has, however, no maximum for any speed, but reaches it greatest value at an infinite speed.

Keeping the speed constant, the electro-motive force of any dynamo-electric machine decreases rapidly with increase of external resistance, and this decrease is more rapid, the smaller the internal resistance or the dynamo-electric machine is made. Hence the currents must decrease much more rapidly than proportional to the total resistance in circuit. And this being the case the external resistance in which the work of the current is done should invariably be made *smaller* than the internal resistance of dynamo-electric machines plus resistance of leading wires.

There appears to be no doubt that an appreciable opposing E. M. F. in the arc is established which acts in opposite direction to the electro-motive force of the dynamo-electric machine, and this E. M. F. of the arc *increases* with the current, passing through the arc; also, the resistance of the arc for constant length is also a function of the current passing through it, *i. e.*, the resistance of the arc *decreases* with the current.

A comparison of the efficiency of the machines tried showed that the dynamo-electric machine A converts 62% of the total energy transmitted into useful work, while 38% is lost in heating the machine. Dynamo-electric machine D converts 30% of the total energy transmitted into useful work, and loses 70% in heating its own wires.

Above 24 Webers, the different dynamo-electric machines produce the Weber at the following consumption of power:—

Dynamo-electric machines A & B	produces *one* Weber at meg-ergs per second.	686·5
Dynamo-electric machine C	produces *one* Weber at meg-ergs per second.	736
Dynamo-electric machine D	produces *one* Weber at meg-ergs per second.	920

As regards the *Regularity of the Electric Light*, it was found that if the resistance external to the Dynamo-Electric Machine is represented by the resistance of the arc only, *i. e.*, resistance of leading wires equal "Nil," then although the light is naturally the most powerful, it is the least steady, since any variation of the resistance of the arc has then evidently the largest influence on the current and on the light.

By connecting across the electro-magnet of an electric lamp, another electro-magnet, which acts as a shunt, and adjusting the two electro-magnets in such a manner that they produce *equal extra currents* when variations in the primary current take place, the regularity of the working of the lamp can be greatly enhanced. An electro-static shunt will have a similar effect. For *strong lights* or *strong currents*, the electro-magnetic shunt is best; for *weak lights* or *weak currents* the electro-static shunt is best.

When making photometric measurements, to get more trustworthy results, it was found best to use *a carbon* (2 to 3 mm. thick) as the positive electrode, and a carbon of the usual form as the negative electrode, the light being observed in a line normal to the flat surface of upper carbon, and passing through the centre of the arc. In this manner the largest quantity of *total light* produced is measured, and, moreover, the ratio between *total* and *external* light is more constant.

The lower carbon should be invariably of less section than the upper carbon, and further, when producing the light by a short arc, which it is always advisable to do, the lower carbon should be *natural* carbon. Coppering the carbon is advisable under all circumstances.

The hissing noise produced by the electric arc is much stronger in a short than in a long arc, and in either case the noise in a quiet room is simply unbearable.

The light permanently decreases with length of arc, hence the arc should be made as short as possible. As this would, however, be bad for the constancy of the light, and may also spoil the dynamo-electric machine, the commutator of the latter should be adjusted by turning the brushes in the direction of the rotation until only small sparks are observed.

Although the light produced in the arc must be very nearly proportional to the total energy consumed in the arc (minus the energy expended in giving the disintegrated carbon particles velocity), the resistance of the arc decreasing with increase of current, it follows that the light *cannot* be proportional to the square of the current. If we make the highly probable supposition that the resistance of an arc of constant length is inversely proportional to the current which passes through, then the light produced would be proportional to the current. This appears to be the case.

DEATH.—Dr. Heinrich Geissler, the inventor of Geissler's tubes, died at Bonn, Germany, on Jan. 24. He began life as a glass-blower, and after some years of wandering, settled down as a glass-blower to the University of Bonn, where he won a world-wide reputation.

Correspondence.

[We do not hold ourselves responsible for the opinions of our correspondents.]

CLERAC'S TUBE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In Nos. 143 and 144 of the TELEGRAPHIC JOURNAL, pages 29 and 49, my name is used in such a way as to place upon me the duty of clearly explaining to the readers of the Journal the true facts which are treated of.

Firstly, in a report upon the Historical Section of the German Telegraph Exhibition, printed in the International Exhibition Journal in 1873, and republished in the *Journal Telegraphique*, Vol. II., Nos. 24 to 26, I have affirmed, according to the *Official Catalogue* on the objects exhibited by the Imperial German Telegraph Administration, that since 1865 resistances of pulverised graphite have been ordinarily used in way stations for regulation of resistances. Thereupon, in No. 27 of the *Journal Telegraphique*, page 425, the invention of powdered carbon resistances was claimed for M. Clerac in the form already cited by Mr. Barrett in page 50 of the TELEGRAPHIC JOURNAL. In my short abstract of the "History of the Electric Telegraph," page 69, and in my "Handbook of Electric Telegraphy," Vol. I., page 518, I have certainly mentioned M. Clerac's claim; but, giving at the same time my sources of information, I adhered to my former assertion and have also referred to older experiments with graphite resistances.

Secondly, Professor Hughes *was therefore mistaken* when he wrote that since then the priority has been freely accorded to M. Clerac. This compelled me to make a correction in the *Journal Telegraphique*, Vol. IV., page 238.

Thirdly, instead of adducing proof of the unreliability of my source, M. Clerac thereupon, in the *Journal Telegraphique*, Vol. IV., page 260, desired of me that I should give the name of the inventor of powered carbon resistance.

Fourthly, Professor Hughes now goes still further, and requires me (TELEGRAPHIC JOURNAL, page 29) to prove that I knew and used powdered graphite resistances before 1866, but, that I have ever at any time, or anywhere, affirmed *this*, is simply not the case.

Fifthly, and lastly, the distinguished M. Du Moncel completely crushes me (TELEGRAPHIC JOURNAL, page 49) by denouncing me as a Prussian, doubtless at the same time with a view to air his profound geographical knowledge. Unfortunately, this gross and groundless calumny now lacks the charm of novelty. It resembles in appearance some earlier and quite baseless aspersions of the Count, which I thought to have duly and finally disposed of in Note 1, page 538, of Vol. I. of my "Handbook."

While I naturally have nothing further to say under the heads of fourthly and fifthly, I content myself once for all with reference to No. 3, by repeating the conclusion of my explanation already made on Feb 1, of this year, to the editor of the *Journal Telegraphique*: "I believe I may, for the present at least, decline to go farther into the question as to the inventor or inventors of powdered carbon resistances, although M. Clerac sets me this task. The question is indeed of very minor importance, for, on the one hand, powdered carbon resistances, on account of their unreliability, have already long ceased to be used in telegraphy, and, on the other hand, the name of the inventor of powdered carbon resistances is also quite without significance for

decision of the question whether or not the adjustment of these resistances to a certain value by pressure screws includes the knowledge and demonstration that the compression of such extremely short duration produced by vibrating bodies are capable of causing so great and constant variations of the current as the microphone requires."

EDWARD ZETZSCHE,
Professor of Telegraphy in the Royal Polytechnic College, Dresden.

Dresden, *Feb.* 17, 1879.

[It is due to Count Du Moncel and to Professor Zetzsche to state that the Count, after penning his letter, printed in our last, subsequently wrote us, asking that the reference to Professor Zetzsche in it should be wholly withdrawn. We should have been very glad to do so, but had, unfortunately, gone to press before the Count's note reached us.—ED. T. J.]

SIR,—In my former communication to your Journal I stated that having made diligent search for any record of a carbon rheostat, involving the principle in dispute between Mr. Edison and M. Clerac, viz., variable resistance with variable pressure, I was unable to find such a record. On the contrary, I found in the *Journal Telegraphique*, of Berne, for 1874, a note which M. Clerac states was written by himself, wherein a rheostat is described composed of compressed carbon, no mention being made of variable pressure; in fact, separate tubes are referred to as constructed to give different, definite, and large resistances which were indicated.

At the same time I accepted unhesitatingly, on Professor Hughes' authority, the statement that M. Clerac had made a carbon rheostat, the pressure of which could be adjusted by a screw. The evidence now brought forward by Professor Hughes to show that a tube of this kind was made in 1865 or 1866 is conclusive, but it does not throw any light on the main points in dispute, which are simply these:—Where was a description of this variable pressure rheostat published, and through what range of resistance could it be made to vary? It is quite beside the mark to say that so many people have seen a tube containing plumbago with a screw at one end; this is not *publication*, and the screw, I suppose, in any case would have been a necessary adjunct to compress the plumbago within, just as a screw is usually fitted to dry piles to squeeze the discs together. I do not say this was the only object of the screw in Clerac's tube, but it seems highly probable that instructions would have been sent with the instrument as to the use of the screw if it were *specially* designed for the novel purpose of varying the pressure on the plumbago, and thereby adjusting the resistance. Hence, though a resistance tube having some resemblance to Edison's carbon rheostat was doubtless made by M. Clerac, the use now claimed for it was generally unknown; so much so that the Count du Moncel, the fellow citizen of M. Clerac, makes no mention of this tube in any edition of his truly admirable and complete "History of the Practical Applications of Electricity."

I am sorry if my esteemed friend Monsieur du Moncel does not think I have done sufficient justice to his researches on the effect of pressure on electric resistance: it was my sincere desire to do so, and if I have made any omission in this direction it has been unintentional, and I will gladly correct it. As I have said, again and again, there can be no doubt that the Count du Moncel first pointed out the effect of pressure on the electric resistance of solids, finely divided and otherwise.

The tone of M. Clerac's letter entirely forbids my having any discussion with that gentleman. If, instead of making offensive imputations, quite uncalled for, and unworthy of a scientific man, M. Clerac had simply pointed out any publication where an account is given of the use of the screw in adjusting the resistance of his tubes, it would have been a valuable contribution to the history of this subject; as it is, M. Clerac has added nothing but another brandishing shillelagh, of which we have had enough already. For my own part I think the entire subject has already received quite as much attention as your readers will care for.

Yours obediently,
W. F. BARRETT.

Royal College of Science,
Dublin, *February* 26.

GAS *v.* ELECTRICITY.

SIR,—My friend Mr. W. H. Preece has lately written an article under the above title, in which I think he does not do himself justice as an electrician, and perhaps I may be allowed to make a few observations upon it. He says:—"We know no more of the electric light now than we did in 1862, when as great a display was made in our Exhibition of that year as was made in the French Exhibition of last year." This, I think, is not quite correct. No one in 1862 ever dreamed of getting more than one light from one machine. I speak of the electric light proper, not an incandescent light produced by contact, where about three-fourths of the current is altogether lost. At that time the machines used were magneto-electric, producing their currents from permanent magnets. Since then, a new and very important class of machines has sprung up, and a dynamo-magneto machine can be made that will give a great number of lights in one circuit according as the machine is wound with large or small wire, and to the amount of power employed in driving the machine. Again, he speaks of a competitive trial of gas and electricity at the Clock Tower, Westminster. As I had something to do with the experiments, and took a great deal of interest in them, I am sure I am not wrong in saying that the electric light was preferred to the gas, but the reason of its not being adopted was because the Gramme patent was in the hands of gentlemen who knew absolutely nothing of the subject, and there was little or no prospect of ever getting a proper machine out of their hands, and I tried myself to get two machines from Paris for the purpose, but the English patent prevented it; and now, instead of having the pure, bright light of electricity, there are three gas furnaces one above another, and doubtless a large quantity of gas consumed. One other observation. In speaking of the multiplication of the light, Mr. Preece states that there is undoubtedly a loss of power in the distribution of the lamps. Now, the loss of power, if it does exist, is not appreciable as far as the Wallace machine is concerned, for we can obtain one light with 20lbs. steam, and as we go on increasing the steam pressure, we can increase the number of lights till at a pressure of 70lbs. we can get eight lights; but the most interesting feature is that, whether we run the machine for one or eight lights, the intensity of each light obtained is the same.

W. LADD.

11 and 12, Beak Street, Regent Street, W.
Feb. 8th, 1879.

THE JABLOCHKOFF ELECTRIC LIGHT.

SIR,—Permit me, as a subscriber to your Journal, to offer a few remarks on the article "Electric Light in Eclipse" in your issue of 15th inst., bearing on, as you call it, the failure of the Jablochkoff system.

The lighting electrically, as carried out by the Societé

General of Paris, is the only method that has hitherto been on any thing like a large scale tested in England. The system is not, as stated, twice as expensive as any other; there is, I believe, very little, if any difference between actual cost of lighting by the various modes, and there is a wide margin between charge for a monopoly as at present existing, and cost with a fair profit, on a large scale, when adopted.

The Jablochkoff light at Billingsgate, on the river side and in the street, was a great success. Within the market itself the substitution of 15 electric candles for 1,100 gas jets was certainly unfavourable, and the pure white light no doubt displeased the vendors of fish, who, by its searching rays, were unable to make the creatures of the deep ought else than what they were.

At Westgate the lighting was undertaken by a gentleman, the proprietor, I understand, of the neighbouring gas works. The experiments were conducted without the assistance or supervision of any one connected with the Jablochkoff Company. On the introduction and trial, for as such it was intended, of a new mode of lighting, surely it was desirable and right that some one thoroughly understanding the subject should have attended to give advice. I see that all was properly worked out, as it was; the candles, which on the Thames Embankment and the Viaduct have never, for now many weeks, burned less than the one and a half hours, with the Westgate sometimes, have only spun out two-thirds of that time; also no tops or covers to the globes were used: in London such are necessary to protect from wind and rain, but in the stormy coast of North Kent, are seemingly unnecessary.

With such and other omissions in carrying out, experiment goes forth, and is extensively circulated; and your Journal endorses the word failure, surely without that proper enquiry which is advisable, in that fairness which I feel sure you desire to extend to all aspirants for the honour of partly illuminating our at present unlighted city. I enclose my card, and remain your obedient servant,

ELECTRODE.

Junior Carlton Club,
18th February, 1879.

[Our statement, to the effect that Jablochkoff's system is twice as expensive as its rivals, was made by Mr. Shoolbred to the Physical Society, on February 8, his estimate being taken from experiments in Paris. We have no wish but to be fair, and gladly publish our correspondent's letter. Trustworthy comparative experiments with different electric lights are much needed.—ED. T. J.]

A MICROPHONE RECEIVER.

SIR,—In trying some experiments some time ago, I was surprised to find that a metal lever resting on a metal point or block acted as a receiver when in circuit with a special transmitter and battery.

Acting on this I devised several receivers, but found that the best results were obtained when a sensitive low-resistance microphone was used. It is well known that the more sensitive we make a microphone of ordinary construction, the greater will be its resistance; and it is evident that if we wish to use two microphones in a circuit as transmitters and receivers, we will require a powerful battery.

I devised a microphone in which sound waves cause vibrations of a small diaphragm instead of acting on a carbon lever. A parchment diaphragm, about two inches in diameter, is fixed to a case somewhat similar to the mouthpiece of a telephone. A small block of carbon is glued to the centre of the diaphragm inside the case, and a carbon lever presses against the block. The lever and block are connected to binding screws on the outside of the case. This microphone is very sensitive and of very low resistance, as the contact between the carbons is good. I have tested every known form of microphone, and some devised by myself, but find the above is preferable for speaking, and for use on telephone lines, besides being more suitable as a receiver than other forms of microphones.

I believe sounds produced by microphones or variable resistance receivers, are due to variable vibrations caused by the current passing through the resistance of the carbons. In support of this theory, I may mention that the microphone when in circuit with a battery, sometimes "sing," making a similar noise to that produced by the telephone in circuit with a microphone and battery. These noises are sometimes as loud as the "singing noises" given out by the telephone, and it is evident that they must be caused by vibrations imparted to the parchment diaphragm by the current.

The "singing" noises of the telephone which have caused some surprise amongst many persons, may be explained in the same way.

Variable resistance receivers are not likely to come into practical use, as better results can be obtained with the telephone, and other magnetic receivers with a less amount of battery power. However, as an experiment, it is worth trying, and may lead to further discoveries in electrical science.

I observe that Prof. Hughes has constructed a variable resistance receiver, but I have not seen particulars of it, and believe that any one who uses the microphone I have described, will get more favourable results, with a less amount of battery power than would otherwise be necessary.

F. DOWLING.

A CARBON TRANSMITTER.

SIR,—To those interested in microphonic experiments I venture to suggest the following one—the outcome of which is the transmission of perfectly articulate speech, without any of the usual hissing sound produced by the microphone. Carbon powder reduced to a state of great fineness, is laid on a board, so as to form a disc about 1½ inches in diameter and one-sixteenth inch thick, into the opposite ends of any diameter of this disc, the terminals of a circuit, in which is a telephone and battery, are introduced to the depth of ¼ of an inch. The powder lies quite loose, and is subject to no pressure whatever. When the powder is spoken to, the words are truly rendered in the telephone, all grating sounds being absent.

FREDK. JOHN SMITH.

Taunton, *January* 29, 1879.

Notes.

THE ELECTRIC LIGHT.—The Wallace-Farmer electric light has been selected to light the pier-head at Avonmouth Dock.

THE Society of Telegraph Engineers have arranged for a great field night with the electric light at the Albert Hall soon. The band will probably play "The Light of other days is faded."

MR. LATIMER CLARK will lecture on the "Electric Light" at the Eyre Arms on March 6.

ELECTRIC INCANDESCENCE.—In an interesting paper in the *Monthly Journal of Science*, Prof. Ayrton arrives at the conclusion that a wire of platinum 1 millimetre in diameter (about No. 20 B.W.G.) and 5 centimetres long can be rendered incandescent by maintaining a difference of potential of 0·285 volts, or about $\frac{1}{4}$ that of a Daniell cell. Similarly, a carbon wire of same diameter, but only 2 centimetres thick (to make it the same resistance as the platinum), requires an electromotive force of 0·460 volts, or about $\frac{1}{2}$ that of a Daniell cell.

DE MOLEYN'S ELECTRIC INCANDESCENCE PATENT.—The first English patent for electric incandescence is, as pointed out by Professor Ayrton, not King's 1845 patent, as is generally supposed, but one dated August 21, 1841, and in the name of Frederick de Moleyns, of Cheltenham, Gloucestershire, for the "Production or development of electricity and its application to illuminating and motive purposes." This ingenious patent describes, among other things, an electric lamp formed of a glass globe enclosing a spiral of platinum wire rendered white hot by an electric current passed through it. An increase of light is also provided for by allowing a stream of carbon dust to fall through the illuminated spiral from a reservoir above.

LUMINOSITY OF INCANDESCENT PLATINUM.—M. J. Violle has measured the intensity of red light emitted by platinum, at different temperatures from 900 to 1·775° C., the melting point of the metal. Taking the intensity of the red light emitted by platinum at 954° (the fusing point of silver) as unity, he finds that the intensity I of the same light at temperature t is represented by the formula

$$\text{Log. } I = 8{\cdot}244929 + 0{\cdot}011475\, t - 0{\cdot}000002969\, t^2$$

which gives

at 800°	I = 0·108	At 1400°	I = 100
900	0·475	1500	194
1000	1·82	1600	327
1100	6·10	1700	481
1200	17·8	1775	587
1300	45·2		

By passing the whole of the rays from fusing platinum through thin plates of rock salt and alumn, and measuring their intensity by a thermo-pile, M. Violle finds that the luminous heat transmitted across the alumn is only $\frac{1}{15}$ of the total heat transmitted by the rock salt. Hence it follows that at 1·775° C. the more refrangible rays appear in greater proportion than at temperatures some hundreds of degrees lower.

WE hear that the city of San Francisco is to be lit by electricity, supplied by the Gramme machine. For this purpose it will be divided into districts, each having a radius of three miles.

THE ELECTRIC LIGHT FOR RAILWAYS.—Our contemporary *Engineering* recently illustrated a travelling electric light generator constructed by the Messrs. Ransomes, Sims, and Head, engineers, Ipswich, which supplies a want felt by railway engineers and contractors for a portable light of great power to be used in illuminating works on the permanent way by night or in tunnels. It consists of a light engine mounted on four flanged wheels, capable of moving itself forward or backward at the rate of 1 to 2½ miles per hour, with a dynamo-electric machine fitted to the front part of the boiler and driven by a strap from the fly-wheel. The light, which may be of any system, is fixed in front of the smoke-box. When the engine travels along the line the dynamo-machine works at its proper speed, and when it is necessary to stop, in order that the light may be directed on some particular spot, the driving wheels are thrown out of gear, and the engine ceases to be a locomotive, whilst the engine continues to drive the machine at its proper speed. Sensitive governors to regulate the current are provided. When not required for lighting purposes the engine may be used to pump water, saw wood, or drill.

WE hear from a private source that Mr. Edison will visit this country in May.

THE TELEPHONE.—It is rumoured that Bell and Gray are likely to come to terms over their telephonic dispute, a consummation devoutly to be wished.

BELL'S TELEPHONE has been fitted up in the rooms of the Royal Geographical Society.

THE MICROPHONE has enabled Mr. Crossley, of the well-known firm of Crossley Bros., Engineers, to hear a fly walking twenty miles distant.

AËRIAL TELEGRAPHY.—Prof. Loomis continues his experiments in telegraphing through the upper air by means of natural currents of electricity, and without the use of wires. He has built towers on peaks of the West Virginia mountains 20 miles apart, and erected metal rods from these as electrodes to pierce the electric strata of the air, and with telephones in this aërial circuit he can converse a distance of 20 miles (?)

THE TELEGRAPH IN CHINA.—We hear that, through the enterprise and wise policy of the Viceroy, His Excellency Li Hung Chang, telegraph stores have been purchased, and that under the direction of Mr. J. A. Betts (the director of the Imperial Torpedo College, Tientsin) the *first* telegraph line for the transmission of *public messages* will be erected, and will probably be in working order within three or four months from this date. This will be a line of some 40 miles in length, and will no doubt be very rapidly extended. Thus we may expect to find that within the next decade the use of electricity in China will be as much a fact as in Europe or America.

SIR J. ANDERSON will lecture on the "Telegraph" at the Working Men's Club, Great Ormond Street, on March 5.

INVIOLABILITY OF TELEGRAMS.—Whether or not telegrams should be regarded as sealed communications, like letters, is a question much discussed just now in the United States, and it is expected to receive the early attention of Congress. It appears that while telegrams are in every American State protected by penal statutes against voluntary disclosure, and are subject to disclosure under judicial authority like other evidence, they are without any protection against a search warrant in the form of the subpœna *duces tecum* except such as may be found in the consciences of those who exercise irresponsible power.

THE GALVANOPHONE, or Electric Songster, an amusing toy, manufactured by the General Novelty Company, is a species of musical telephone, actuated by a bichromate battery, seems capable of affording a good deal of fun, as it is in the habit, like some of Lord Beaconsfield's heroines, of occasionally bursting into melody.

As the West India and Panama Company's repairing ship, *Investigator*, was leaving St. Thomas, on Jan. 8, her boiler exploded.

TELEGRAMS can now be sent all over Guatemala for a shilling. The lines are Government property, and are superintended by Mr. Stanley McNider.

CURIOUS THERMO-MOTOR.—Profs. Elihu Thomson and Edwin J. Houston, two American men of science, who labour in a truly scientific spirit, and not, as is too common in their country, for mere gain, have recently devised a motor which possesses a theoretical interest. A small wheel or disc of steel is placed between the poles of a horse-shoe magnet, where it is free to rotate round an axle, the edges of the wheel being opposite the poles. In this position the wheel of course becomes magnetised by induction. If now any section of the wheel be heated the disc will move, because the heat lessens the coercive force of the heated part, and hence the magnetic equilibrium is disturbed, producing motion of the wheel.

EXTENSION OF DR. KERR'S EXPERIMENT.—It is well known that a block of glass, through which a powerful discharge of electricity is passed, that is, a block subjected to intense electro-static stress, has power to shift the plane of polarisation of light. This is usually shewn by projecting the beam of polarised light which traverses the glass on a screen where it makes a white spot. While recently performing this experiment, Mr. J. E. Gordon, B.A., accidentally allowed the electro-static stress to become strong enough to perforate the glass. Immediately before perforation there appeared first a patch of orange-brown light about 6 or 7 inches diameter upon the screen. This at once resolved itself into a series of four or five irregular concentric rings dark and orange brown, the outer one being perhaps 14 inches diameter. In about two seconds more these vanished and were succeeded by a huge black cross about 3 feet across, seen on a faintly luminous ground. The arms of the cross were along the planes of polarisation, and therefore (the experiment being arranged according to Dr. Kerr's directions) were at 45° to the line of stress. The glass then gave way, and all the phenomena disappeared except the extreme ends of the cross, and the discharge through the hole, where the glass had been perforated, was alone seen.

IN a letter to the Philadelphia *Times*, Mr. David Brooks, the well known inventor of Brook's insulator, lays claim to having first discovered that a two-twisted wire circuit overcame the induction clamour on telephone lines, a plan which has been patented by Prof. Bell.

HEAT OF MAGNETISATION.—Prof. Hill, of the United States Torpedo Station, Newport, R.I., finds that the molecular heat developed in equal volumes of iron, cobalt, and nickel, by rapid magnetisation, expressed in work done, was for iron 2381·43, for cobalt 1906·50, for nickel 1112·11 metre-grammes.

New Patents—1879.

485. "Improvements in and appertaining to sounders for telegraphic purposes. J. R. EDWARDS. Dated Feb. 7.

508 "Improvements in shades or lanterns for electric or other lights." H. VANDER WEYDE. Dated Feb. 8.

513. "Improvements in electro-dynamic apparatus." JOHN IMRAY (communicated by Francois J. Endrés, Paris). Dated Feb. 10.

523. "Improved apparatus for obtaining electric currents, and means for obtaining light from electric currents." E. T. BOUSFIELD and W. R. BOUSFIELD. Dated Feb. 10.

529. "An improved process of electro-plating by an amalgamation or combination of silver and alloys of tin and other metals, to be called 'silverette.'" T. H. BLAKE. Dated Feb. 11.

565. "Improvements in the construction of dynamo-electric machines employed for generating electric currents." JOHN FORMBY. Dated Feb. 13.

595. "An improved method of generating compound induced currents for telephonic and other purposes. R. H. COURTENAY. Dated Feb. 14.

ABSTRACTS OF PUBLISHED SPECIFICATIONS—1878.

1988. "Phonic wheels." PAUL LA COUR. Dated May 17. 6d. This describes various phonic wheels, or toothed discs rotated by the electro-magnetism generated by harmonic currents. (See TELEGRAPHIC JOURNAL, Dec. 1, 1878.) The wheel can be used as a motor or an automatic speed regulator, for chronographs, &c.

2003 "Apparatus for the generation and application of electricity, for lighting, plating, &c." H. J. HADDAN. Dated May 18. 1s. This describes Brush's electric lighting apparatus. (See TELEGRAPHIC JOURNAL, Jan. 15, 1879.)

2024. "Continuous rolling-mills." B. J. BARNARD MILLS. (Communicated by W. R. Jenkins, jun., Bellefonte, United States. Dated May 21. This relates to the construction of the rollers of telegraph and other wire mills without twisting guides.

2096. "Hydro-electric brake for railway trains, &c. W. MORGAN-BROWN. (Communicated by Jules Sabatier, and Louis Pouget, Montpellier, France.) Dated May 25. 6d. Electricity is employed to apply the brake, the motion of the train is made by means of hydraulic pressure to arrest the latter.

2137. "Telegraph signalling apparatus for increasing the speed of working telegraph cables, &c." FREDERICK TRIMMER. Dated May 29. 2d. One or more electro-magnets with armatures actuated either by a local battery or the working battery, are combined with the peg in such a way that they curb the signal currents. *Not proceeded with.*

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AT the meeting of this society, held on February 13th, Major Bateman-Champain (President) in the Chair, Mr. Willoughby Smith read a paper on the "Working of Long Submarine Cables."

In commencing his paper, Mr. Smith put together a brief history of the working of long submarine cables from twelve years ago up to the present time. When electro-magnets were introduced into the instruments used for working long lines, retardation of signals was produced, to overcome which Jacobi employed "polarisation" batteries. In 1860, Mr. C. F. Varley effected the same object by means of "condensers," and in December, 1862, the same gentleman adopted condensers and resistance coils combined, so as to

produce quick signalling on submarine cables, also employing an iron core in the resistance coil to produce a more effective result. Several combinations of these elements were suggested by Mr. Varley, but none, as far as Mr. Smith was aware, were practically tried.

In 1865, the "curb key" was devised by Sir Wm. Thomson and Mr. Varley for working the Atlantic Cable laid in that year. In this instrument, by a mechanical arrangement, three or more currents of equal strength, but of unequal duration, could, in quick succession, be alternately sent through the cable. On working this key through the cable coiled on board the *Great Eastern*, a speed of about six words a minute was attained.

In 1866, Mr. Smith introduced his well-known method of continuous testing, by which messages could be transmitted between the ship and shore without interrupting the insulation test. This system was improved by Mr. Laws and Mr. Varley. On practically working this system, it became apparent that a speed of signalling could be obtained with it greatly in excess of that which could be obtained with the curb key; in fact, as high a rate as thirteen words per minute was attained with ease, and subsequently this was increased to twenty-five words as the clerks became skilled in the working.

In drawing a comparison between the mirror and the siphon recorder systems of working, Mr. Smith stated that a *good* mirror clerk prefers the mirror instrument, while an *inferior* reader prefers the recorder.

In considering the question of the use of electro-magnetic shunts for working long submarine circuits, Mr. Smith stated that all his experiments tended to show that their employment was prejudicial to a high working speed.

At the conclusion of his paper, Mr. Smith gave some details of experiments on duplex working through cables, showing what balancing, resistances, and capacities gave the best results, the signals being received on a siphon recorder.

A paper by Mr. J. GRAVES, of Valentia, on "Curbed Signals," was then read by the Secretary.

In the discussion which followed the reading of the papers, Mr. C. F. Varley pointed out the advantage to be gained by the use of a resistance coil combined with the condenser at the receiving end of the cable, the resistance enabling the cable to discharge itself more readily.

The meeting then adjourned.

PHYSICAL SOCIETY.

AT the meeting on Feb. 22, Prof. W. G. ADAMS (President) in the Chair,

Dr. C. W. SIEMENS gave an account of his current regulator, illustrated by us in this number. Dr. Coffin stated that he had thought of a regulator in which the heating of a spiral wire in a gaseous chamber would cause the gas to expand and drive up a column of mercury past a series of contacts, which would throw resistances in circuit. Dr. Guthrie suspected from some experiments of his that the conductivity of metals was not strictly proportional to their sectional area.

Dr. SCHUSTER then read a paper on "The Spectrum of Lightning." He stated that while in Colorado last year on the Eclipse expedition, he had made three observations of the spectrum of lightning: one at Las Animas, on horizon lightning, one in the Rocky Mountains, at Manitou Springs, on the flashes from a cloud overhanging Pikes Peak, and one in front of the hotel at Salt Lake City. The spectrum showed three nitrogen lines and four bands, one of the bands, however, being doubtful. One of these bands is that obtained from oxygen at low temperatures, but Dr. Schuster has tried in vain to get it from air. On the whole, Dr. Schuster is of opinion that the bands agree, but with the spectrum of the light seen at the negative pole of a discharger in oxygen mixed with a trace of carbonic oxide.

City Notes.

Old Broad Street, Feb. 26, 1879.

THE fifteenth ordinary general meeting of the Cuba Submarine Telegraph Company (Limited) took place on Wednesday, the 19th inst., at the offices, Old Broad-street, under the presidency of Mr. Thomas Hughes, Q.C., the Chairman of the Company. The report, an abstract of which appeared in our last issue, having been read, the Chairman, in moving the adoption thereof, first alluded with very deep regret to the sudden death on the previous Sunday of the chief officer of the Company, Mr. Brand, who had been their secretary and manager from the establishment of the Company ten years ago. He was sure that the shareholders would regret his decease as deeply as the directors did. They would do their best to supply his place as worthily as possible. As to the question of dividend, they had recommended one at the rate of only 6 per cent. per annum on the ordinary shares, and he thought that, considering the state of their property in the West Indies, they would all be of opinion that that dividend was quite as much as they could prudently declare on the present occasion. That time last year several shareholders expressed the opinion that the Company could have quite fairly declared a larger dividend, and they founded their views as to the amount of the dividend which should be declared upon the fact of the vastly improved condition of the cable. Mr. Hooper, too, whose knowledge made him an authority on such a subject, argued as a reason for the dividend being increased that the "life" of the cables would prove to be considerably longer than the estimate adopted by the Board. He, however, thought the experience of the past year had shown that the policy of limiting the dividend was a wise one, because it seemed to show that the "life" of the cables, so far from being longer than the Board estimated—10 years—was likely to prove shorter; and they had also had the misfortune to have again to undertake the repair of faults in their cable. That morning they received a telegram from their manager at Jamaica—who was now engaged in the repair of the cable—to the following effect:—"Picked up cable; lost the Santiago end, and buoyed the Cienfuegos"; so they might expect almost immediately to hear that the first portion of his work had been satisfactorily performed. Until, however, the whole of the work had been completed they could not ascertain what the expense would be with any certainty, and therefore they recommended the dividend mentioned, and that the whole of the balance of £4,053 should be carried forward, so that they might be enabled to pay the expenses out of it. The decree of the Court of Madrid as to the tax imposed by the Spanish Government upon the local business of the Company, had been received, and the result was that the claim of the Company had been, to a great extent, allowed, and about £1,200 would have to be returned to them by the Spanish Government. The motion having been seconded, the Chairman, in reply to questions and observations, said that negotiations were going on as to the Para cable, and they trusted that the connection might be made with South America, which would be of immense advantage to this Company. The opinion of

the Board as to the "life" of a cable, was of no more value than that of other persons connected with telegraphic business, but they had only to look to facts as connected with their own business; and although he admitted that their experience might be exceptional, he did not think they would be justified in treating their cable as likely to have an undisturbed "life" of more than ten years. Experience showed that the West Indian seas were not favourable to the "life" of a cable. As to the remarks about the defective nature of the last cable laid for them—the india-rubber cable—it had been constantly under the consideration of the Board whether there was any fault attributable to the manufacturer; but it was impossible for them to ascertain whether the fault lay with, and could be brought home to, the manufacturer or not till the fault was reached. The cable, however, was constantly inspected and severely tested during its manufacture by Mr. Keith, who was now repairing it. The motion was then unanimously adopted, and the dividends having been declared, a vote of thanks to the Chairman and directors terminated the proceedings.

According to the report of the Telegraph Construction and Maintenance Company (Limited) the accounts for the year show a net profit of £87,746, after charging the interest on the Debentures. To this sum must be added £61,247 brought forward from last year, making a total of £148,993. From this amount is deducted the interim dividend of 5 per cent., paid 10th July, 1878, amounting to £22,410, leaving £126,583 to be dealt with. Of this sum the directors propose to distribute a dividend of 15 per cent., or £67,230, being at the rate of £1 16s., per share, and making with the amount already paid, a total dividend for the year of £2 8s. per share in cash, free of income tax, leaving £59,353 to be carried forward to the next account.

The Western and Brazilian Telegraph Company (Limited) notified on the 15th inst. that telegraphic communication has been completed from Para to Monte Video. This places the Company's entire system, including the new line into Maranham, for the *first time* in complete working order. The cables are now working from Para to Monte Video, including all the intermediate ports required by the Company's concession. During the last twelve months, out of the original Western and Brazilian line from Rio de Janeiro to Para, viz., 2,517 miles, 830 miles of new cable, nearly all sheathed, has been relaid in shallow waters, leaving but a moderate length in these waters which it will be necessary hereafter to renew. The engineers report that the original cable, laid in deep water, is in excellent condition.

The Anglo-American Telegraph Company's Brest cable was broken on the morning of the 23rd inst. during a violent temptest, which had been raging for 36 hours. The cable was broken about 161 miles from St. Pierre, in 500 fathoms of water. The Company's ship has been ordered to sea at once to effect the repair.

The Direct U.S. cable is not yet repaired, there are therefore at present but two Atlantic cables at work both are, however, duplexed.

The following are the latest quotations of telegraphs:—Anglo-American, Limited, 59-59½; Ditto, Preferred, 86-87; Ditto, Deferred, 31-31½; Black Sea, Limited, —; Brazilian Submarine, Limited, 6¾-7½; Cuba, Limited, 8¼-8¾; Cuba, Limited, 10 per cent. Preference, 15½-16; Direct Spanish, Limited, 1½-2; Direct Spanish, 10 per cent. Preference, 10-10½; Direct United States Cable, Limited, 1877, 11½-11¾; Eastern, Limited, 7¼-7½; Eastern, 6 per cent. Debentures repayable October, 1883, 104-107; Eastern 5 per cent. Debentures repayable August, 1887, 100-103; Eastern, 6 per cent. Preference, 11¼-11¾; Eastern Extension, Australasian and China Limited, 7¼-7½; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; German Union Telegraph and Trust, 7¾-8¼; Globe Telegraph and Trust, Limited, 4¾-5½; Globe, 6 per cent. Preference, 10⅜-10⅝; Great Northern, 8⅛-8⅜; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 9-9½; Reuter's, Limited, 9½-10½; Submarine, 215-225; Submarine Scrip, 1¾-2⅛; West India and Panama, Limited, 1¾-2⅛; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 7¾-8¼; Western and Brazilian, Limited, 4¼-4⅝; Ditto, 6 per cent. Debentures "A," 88-93, Ditto, ditto, ditto, "B," 83-88; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 31¼-32½; Ditto, 6 per cent. Bonds, —; Ditto, Second Bonus Trust Certificates, 2⅛-2½; India Rubber Co., 10¾-11¼.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£ *b*	£	£	£ *b*	£
January, 1879 ...	50,400	13,778	*2,900	951	16,800	39,226	24,695	13,856	... ...	9,064	2,125	... ...	5,497
January, 1878 ...	49,940	11,883	3,001	944	13,730	41,531	22,905	13,521	... ...	9,621	1,725	... ...	5,284
Total Inc., 1879	*460	1,895	... ...	7	3,070	... ...	1,790	345	... ...	... ...	400	... ...	213
Total Dec., 1879	... ...	... ...	101	... ...	... ...	2,305	... ...	... ...	... ...	557	... ...	... ...	... ...

* Estimated. *b* Not published. Traffic Receipts of West Coast of America Co. for the month of December were £2,250.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)